Colour-changing Metasurface For Displays And Customizability

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Vision

Our goal is to create a low power, colour changing surface to enable a range of novel technologies.

Bright-light Visibility

Real-time Customization

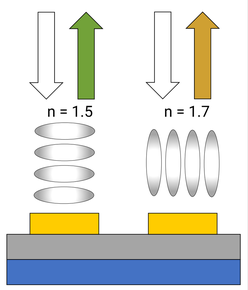
Vibrant Notifications

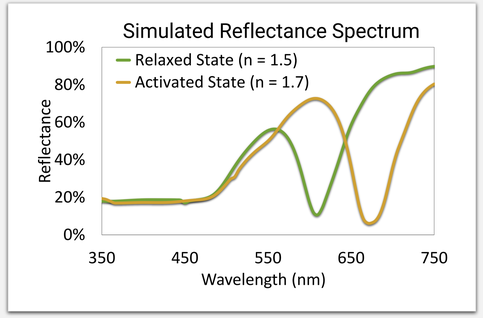
Existing technologies have many flaws:

- Colours fade in bright conditions
- Up to 80% of energy consumed by backlight
- Manufacturing process is complex and expensive

Mechanism

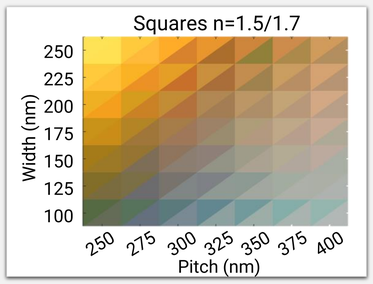
Interactions between specific wavelengths of light and plasmonic structures induce absorption of that wavelength, a phenomenon termed localized surface plasmon resonance. Due to the wave-nature of light, these interactions exhibit sensitivity to the refractive index which, if altered, changes the colour reflected by the plasmonic structures. Liquid crystal has an orientation-dependent refractive index which can be controlled by an electric field. This allows the device to actively change colour.

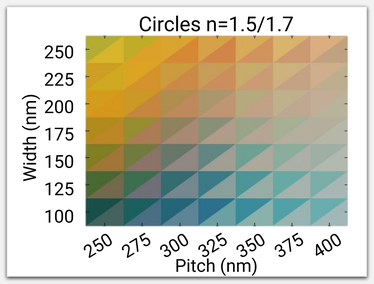




Simulations

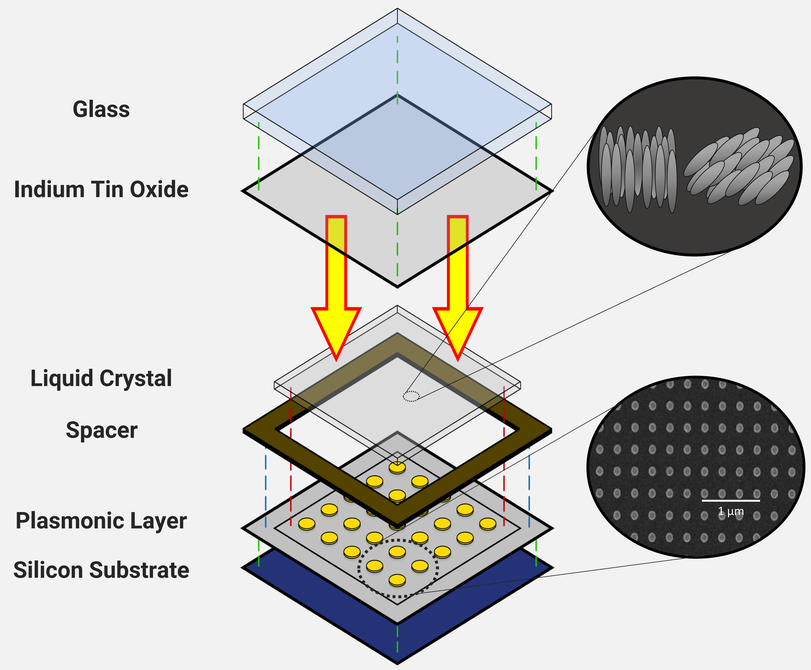
By controlling the pitch and width of the plasmonic features, the structures can be designed to produce many different colours. RSoft was used to model these structures and predict the colour range achievable with liquid crystal.



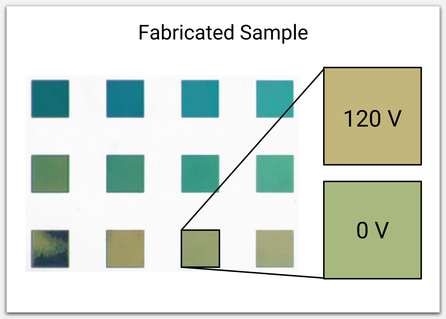


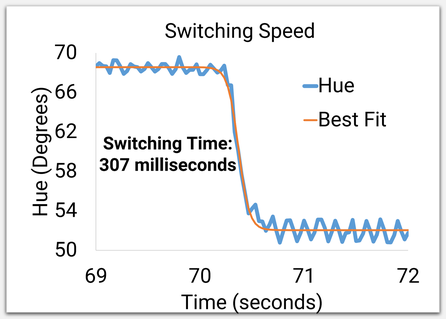
Device

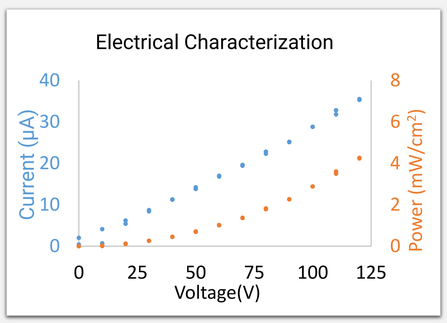
The device features an array of gold nanostructures immersed in a layer of liquid crystal situated between two electrodes. The orientation of the liquid crystal can be controlled by applying a voltage across the electrodes, resulting in a tunable colour response.

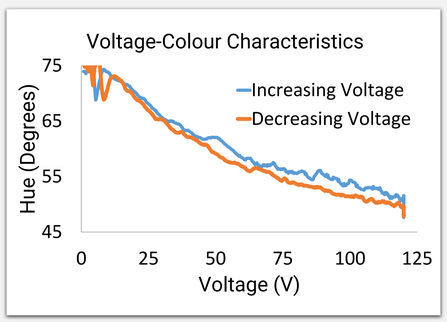


Performance



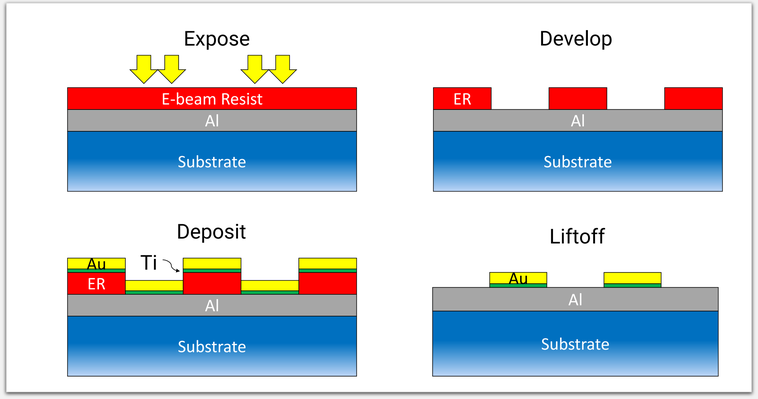






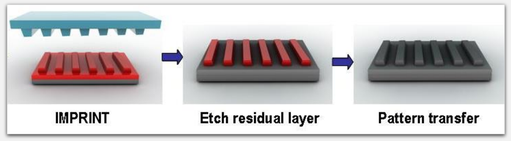
Fabrication

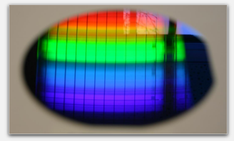
Electron-beam lithography was used in conjunction with sputtering and liftoff to rapidly prototype plasmonic nanostructures.



Scalability

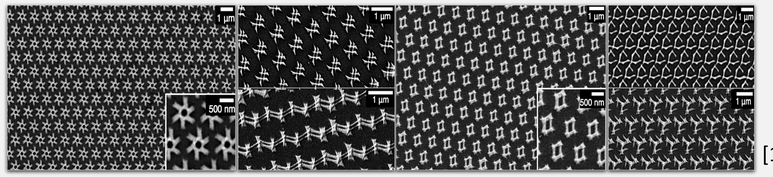
This device has been designed to be compatible with photolithography, nanoimprint lithography, and interference lithography. These methods allow for large areas to be fabricated quickly and inexpensively.





Future Work

- Explore different geometries and lattice structures
- Try alternative plasmonic materials such as silver
- Investigate other mechanisms of changing the refractive index



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Acknowledgements

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References

[1] A. Nemiroski, M. Gonidec, J. M. Fox, P. Jean-Remy, E. Turnage, and G. M. Whitesides, “Engineering shadows to fabricate optical metasurfaces.,” ACS Nano, vol. 8, no. 11, pp. 11061–70, Nov. 2014.